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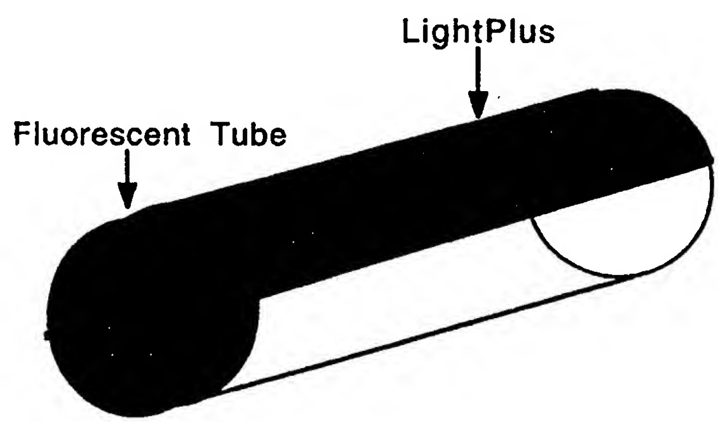
With international search report.

(54) Title: LIGHT PLUS

(57) Abstract

A method of light reorientation and recovery, is based on circular mirror system (figure 2) that has the same radius of curvature and the same center as that of the light source with which the system functions. These characteristics allow the system to reorient light rays striking the surface normally in the opposite direction toward the centre of the light source. This reoriented light flux passes through the centre of the light tube, exits, and combines with the non reoriented light flux to give more visible light to the areas desired. In a fluorescent tube, the system is mounted outside the light tube surface, and directly reorients the visible light, or mounted inside the light tube surface, and reorients the ultraviolet light toward the other side of the tube where it then undergoes fluorescence. In either case, the end result is more visible light to the areas where it is desired.



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Description: Light Plus

Introduction:

The present invention reorients the light flux of a fluorescent tube to places where it is needed most yielding a larger intensity of visible light. More specifically, it reorients a maximum quantity of light flux with the greatest efficiency in the direction desired. The method proposed here attempts to minimise the losses due to absorption, remission, and reflection caused whenever light strikes a surface by minimising the number of reflections light undergoes before reaching the areas where it is most needed.

Theory of the Invention:

The invention is based on a method of reflecting light rays by a system characterised by the following:

- A thin reflective layer which is circular in form.
- The radius of curvature of this reflective layer is that of the cylindrical light tube with which it functions.
- The centre of this reflective layer corresponds to the same centre of the cylindrical light tube with which it functions.
- The reflective layer is mounted on the surface either inside or outside the cylindrical light tube with which it functions.

These characteristics allow the system to reorient each light ray striking its surface normally in the opposite direction toward the centre of the cylindrical light tube (see Figures 2a, 2b, 3a, and 3b). The reoriented light flux passes through the centre of the tube, exits the tube on the opposite side, and combines with the non-reoriented light rays resulting in a greater intensity of the visible light.

Application to the Fluorescent Tube:

One important type of cylindrical light tube for which the invention can be applied is the fluorescent tube. The operation of such light tubes is well known. Briefly, an electric discharge across a low pressure mercury vapour produces emissions of ultraviolet light at a

frequency of 2537Å. Although light at this frequency is not visible to humans, this light impinges a thin fluorescent layer coating the inside of the light tube to produce visible light according to Stokes Law. The resulting light contains a part perpendicular to the surface of the tube.

This is the reason this method of reorientation applied to the fluorescent tube is characterised in the following ways:

- The primary light emitted normally to the surface of the tube is reoriented in the opposite direction, passes through the centre and exits from the other side of the tube toward the areas desired.
- The secondary light emitted at other angles to the surface of the tube is reoriented near the centre of the tube or again toward the mirror and follows a path to exit from the other side of the tube toward the desired areas (see Figures 3a and 3b).

This is also the reason that the application of the method to the fluorescent tube is distinguished in two different ways. In the first, the system is mounted outside the tube and directly reorients the visible light produced by the fluorescent layer of the tube. The second way consists of mounting the system inside the tube to reorient the ultraviolet rays toward the other side of the tube where they undergo the process of fluorescence and consequently produce visible light. Regardless of the way the method is applied to the fluorescent tube, the results are the same: the visible light flux composed of reoriented light and non-reoriented light, is more intense in the directions where it is most desired.

Model:

In practice, the invention is implemented by a system composed of an extremely reflective layer that is in direct contact with the surface of the tube, either on the interior or exterior surface of the tube. The simplest system consists of two parts:

1) A thin reflective layer.
2) A means of attachment to the tube.

The layout of the system is shown in Figures 1a and 1b.

1) The Thin Reflective Layer

The thin reflective layer serves as the mirrored surface of the system. It is from a flexible material like plastic or paint with high reflectivity (greater than 95% reflectivity) and resistant to the average operational temperature of a standard fluorescent tube. The size of this thin layer depends on the tube with which it functions as well as the quantity of light flux desired (see Section Results).

2) The Means of Attachment

The mechanism of attachment serves to put in contact the thin reflective layer with the fluorescent tube. It is accomplished with a cohesive material like tape or clips as shown in Figures 1a and 1b. The cohesive material or clips are made of non-toxic materials which are resistant to the average operational temperature of a standard fluorescent tube. The adhesive material or clips are placed at each extremity of the thin reflective layer as well as at regular intervals along the length of the tube.

Two versions of the invention have been created and tested, notably one with tape and one using clips. The two versions covered 50% of the surface of the light tube by the reflective layer and functioned outside the light tube. It should be mentioned that the workings of the system are exactly the same for application of the invention inside the tube, except for the fact that it is necessary to change the reflective material to that for ultraviolet light.

Results:

Two different types of tests have been performed for the two models of the invention: 1) A test with an isolated fluorescent tube and 2) A test with the fluorescent tube and its original system of light diffusion.

1) In comparison to the isolated fluorescent tube, the invention increased the light flux between 32% and 36% to the areas desired,

corresponding to an efficiency of reorientation between 64% and 72%.

2) In comparison to a fluorescent tube with its original system of light diffusion, the invention increased the light flux between 11% a and 23% to the areas desired (according to the original system of diffusion), corresponding to an efficiency of reorientation between 22% and 46%.

Theoretically, the quantity of light flux which can be attained corresponds exactly to the surface of the fluorescent tube covered divided by the area of the surface of the entire tube according to the inverse square law for the flux of light. In application, this quantity corresponds to the angle swept by the circular-reflective layer covering the tube. The corresponding quantity of light flux which can be attained by the system is calculated from the following formula:

$$F_{ideal} = \left(\frac{\alpha}{2\pi}\right)$$

where F_{ideal} represents the ideal quantity of light flux added in per cent, α represents the angle swept by the circular-reflective layer of the system covering the tube in radians, and 2π is the angle traversed by a circle in radians. Actually, this formula represents the ideal case, however in practice the efficiency of the reflection must be taken into account as shown in the following formula:

$$F_{real} = \left(\frac{\alpha}{2\pi}\right)\varepsilon$$

where F_{real} is the real quantity of light flux increased in per cent and ε represents the efficiency of reorientation. This is the reason why the method of reorientation of the light flux is characterised by the angle swept by the reflective layer and corresponds to the quantity of light flux obtained up to 50%. This is also the reason that

the direction of the reoriented light flux can be controlled by this method through the orientation of the thin layer on the light tube.

Although it is possible to cover more than 50% of the surface of the light tube, the results are less efficient. In fact, the most efficient results are obtained when 50% of the surface of the tube is covered by the thin layer and 50% is exposed to the areas desired (see Figures 2a and 2b). Under these conditions, 50% of the light exits directly from the fluorescent tube and the other 50% after reflecting from the reflective layer a minimum number of times.

Conclusion:

In conclusion, the present invention proposes a method of reorientation of light flux with a circular mirror system having the same form, the same radius, and the same centre as that of the light tube with which it functions. This allows each normal ray of light to be reoriented in the opposite direction toward the centre of the light tube. The reoriented light flux passes from the centre of the light tube, exits the tube at the other side, and combines with the non-reoriented light flux to result in more visible light.

In application of the invention to the fluorescent light tube, a cohesive material or clips connect the thin layer of extremely reflective material to the surface of the tube. The system functions outside the tube by directly reorienting the visible light or inside the tube by reorienting the ultraviolet light that then undergoes the phenomena of fluorescence on the other side of the tube.

In application to the fluorescent tube, the invention has several advantages for increasing the visible light flux to areas desired. Among these advantages are the following:

1) The system doesn't use electricity.
2) The system possesses a life which is practically unlimited.
3) The system installs directly on the lighting which is in place and in the same time as that for a simple fluorescent tube.

4) The system costs less than the average price of a standard fluorescent tube.
5) The system increases the visible light flux up to 36% to the areas desired.

Claims:

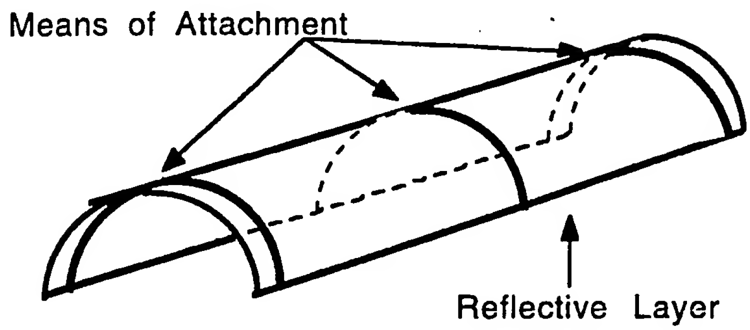
1. The method of reorientation of light flux otherwise disperses away from the desired areas for cylindrical light tubes. The method is characterised by the fact that:
- The primary light emitted normally to the surface of the tube is reoriented in the opposite direction, passes through the centre, and exits from the other side of the tube toward the areas desired.
- The secondary light emitted at other angles to the surface of the tube is reoriented near the centre of the tube or toward the reflective surface and follows a path to exit the tube toward the desired areas.

2. The method in accordance with Claim 1 and effectuated by a reflective system which is characterised by the following:
- A thin reflective layer which is circular in form.
- The radius of curvature of this reflective layer is that of the cylindrical light tube with which it functions.
- The centre of this reflective layer corresponds to the same centre of the cylindrical light tube with which it functions.
- The reflective layer is mounted on the surface either inside or outside the cylindrical light tube with which it functions.

3. The method according to Claims 1 and 2 and characterised by the fact that the angle swept out by the reflective layer on the cylindrical light tube is directly related to the quantity of light flux obtainable and for which the direction can be controlled by the orientation of the reflective layer on the light tube.

Figure 1: Light Plus - Description

1a) Perspective View



1b) Side View

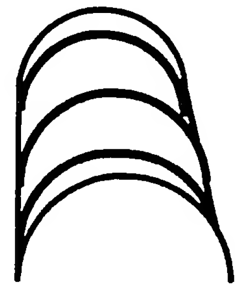
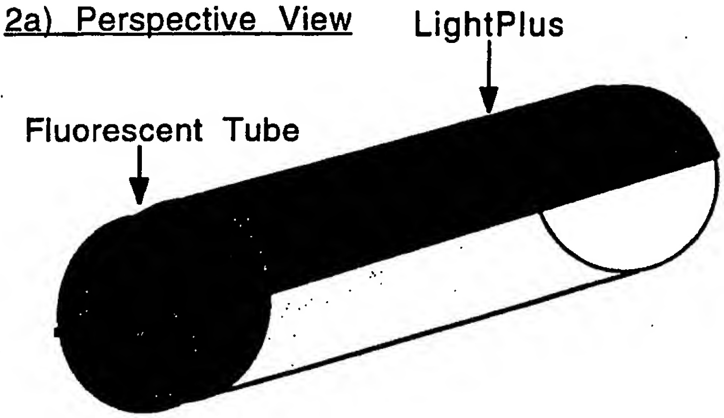


Figure 2: LightPlus - Application

2a) Perspective View



2b) Side View

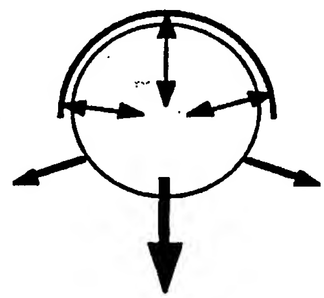
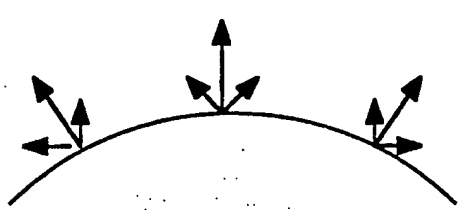
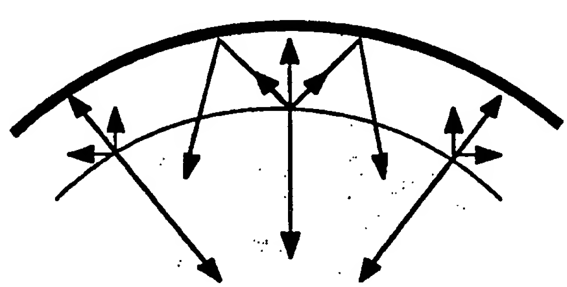


Figure 3: LightPlus - Method of Operation

3a) Fluorescent Light Tube



3b) Light Tube with LightPlus



INTERNATIONAL SEARCH REPORT

International application No.
US93/02760

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :H01J 1/70
US CL :313/113,489
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4,336,479 (KODAMA ET AL.) 22 June 1982, See column 4, lines 9-13, figures 4A and 4B.	1-2
X	US, A, 4,255,687 (van ENGELEN ET AL.) 10 March 1981, See column 2, line 5-31.	1-2
X	US, A, 3,767,956 (BAUER) 23 October 1973, See entire document.	1-2
X	US, A, 3,225,241 (SPENCER ET AL.) 21 December 1965, See column 3, line 31-column 4, line 33.	1-2

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/02760

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 3
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

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3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

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☐ The additional search fees were accompanied by the applicant's protest.
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